

***Boea resupinata* Zich & B.Gray (Gesneriaceae), a new species from Cape York Peninsula, Queensland, Australia**

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Summary

Zich, F.A. & Gray, B. (2021). *Boea resupinata* Zich & B.Gray (Gesneriaceae), a new species from Cape York Peninsula, Queensland, Australia. *Austrobaileya* 11: 56–66. *Boea resupinata* is described as new. It is compared to its putative closest relative, *Boea magellanica*, and to the most similar Australian species, *B. hygroskopica*. A modified key to all species of *Boea*, and images of the plants, flowers, leaf micromorphology and leaf anatomy of *B. resupinata* are provided. Notes are given on flower morphology, leaf micromorphology and anatomy, conservation status and habitat.

Key Words: Gesneriaceae; *Boea*; *Boea resupinata*; Australia flora; Queensland flora; new species; taxonomy; identification key; resurrection plant

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Introduction

Boea Comm. ex Lam. is classified in the subtribe Loxocarpinae, tribe Trichosporeae, subfamily Didymocarpoideae, in the Gesneriaceae (Weber *et al.* 2020). Puglisi *et al.* (2016) recircumscribed genera in the Loxocarpinae, a subtribe which comprises 200 species in 15 genera, transferring a number of species out of *Boea* and narrowed the concept of the genus to be an Australasian group characterised by twisted fruit, free (or nearly free) sepals, a flat-faced pink to purple corolla, and exserted and strongly divergent anthers. *Boea* as revised by Puglisi & Middleton (2018) contains 11 species, distributed in Papua New Guinea, the Solomon Islands, Australia (Queensland) and Indonesia (Waigeo Island).

Australia has two named species (APC 2020): *Boea hygroskopica* F.Muell. and *B. kinnearii* (F.Muell.) B.L.Burt that both occur in the high rainfall areas of the Wet Tropics and southern Cape York Peninsula of tropical Queensland. In addition to these, an unnamed species has been recently recognised from northern Cape York Peninsula. The new

species was first collected in 1948 (*Brass 19408*, BRI & CANB) and since then there have been several additional collections. Although early collectors considered the specimens potentially distinct from *Boea hygroskopica* their material was subsequently identified as that species and the distinctness of the taxon was overlooked until photographs of flowering plants in cultivation by Garry Sankowsky and Bruce Gray were examined in detail by the first author and the distinct features of the flowers were observed. The new species is endemic to northern Cape York Peninsula and is named here as *Boea resupinata*. Modifications are provided to the key to all species of *Boea* by Puglisi & Middleton (2018).

Material and methods

This paper is based on an examination of specimens at CNS, BRI and CANB. Descriptions of flowers are based on material preserved in spirit and on living material, while other features were measured from dried specimens. Abbreviations used in the

specimen citations include QRS (Queensland Research Station) for specimens now incorporated at CNS. Measurements are inclusive, viz. 2.7–4.0 given as 2.7–4.

Scanning Electron Microscopy (SEM): Fresh leaf pieces were harvested into 3% Glutaraldehyde in 0.1M Cacodylate buffer and washed 3 times with fresh buffer. After post fixation with osmium tetroxide (1 hour at room temperature), the samples were washed 3 times with deionised water. Samples were then dehydrated in an ethanol series from 30–100% concentration for 15 minutes each ($3 \times 100\%$) and critical point dried (Quorum E3000 Series). Samples were then mounted on stubs, gold-coated (SPI Module) and imaged in a Hitachi SU5000 FEG SEM.

Histology: Fresh leaf pieces were immersed in 10% neutral buffered formalin for 24 hours, transferred to 70% ethanol and placed into an automatic tissue processor (Histocore Pearl, Leica), then embedded in paraffin blocks (Histocore Arcadia, Leica). Sections of 5 μm thickness were then cut on a rotary microtome, mounted on glass slides and stained with 0.1% toluidine blue. Images were obtained using a Leica CS2 digital scanner at $20\times$ magnification.

Taxonomy

***Boea resupinata* Zich & B.Gray sp. nov.**

With affinity to *B. magellanica* Lam. but differing by the multicellular hairs on the petal lobes, the strongly bent filaments, the serrulate to serrate leaf margin, and inverted corolla with the 3-lobed lip in the upper position and the 2-lobed lip in the lower position. **Typus:** Queensland. COOK DISTRICT: Cultivated: QRS [Queensland Research Station], Atherton (ex Claudie River, September 1978), 7 February 1979, *B. Gray 1268* [flowering] (holo: BRI [AQ0873878]; iso: CNS [QRS54614]).

Rhizomatous, perennial, shortly caulescent or rosulate herb; stem if present up to 6.2 cm long, 4–5.5 mm diameter, woody, with translucent, white, multicellular unbranched hairs. Leaves congested at apex of stem, opposite or whorled, petiolate; petioles longer in older peripheral leaves than upper central leaves, 1.2–4.5 cm

long, 1–2 mm diameter, densely appressed hirsute with a translucent, white indumentum. Lamina elliptic to ovate, $3\text{--}12.4 \times 2\text{--}6.3$, 1.5–2.5 times as long as wide; base acute to cuneate, oblique; apex acute to obtuse; margin serrulate to serrate. Adaxial leaf surface light-mid green, densely hirsute with an indumentum of translucent, white, appressed, multicellular, unbranched, eglandular hairs, and sparse, gland-tipped hairs. Abaxial leaf surface light-mid green, less densely hairy than adaxial surface, hairs mostly on veins, with translucent, white, multicellular, unbranched hairs, and sparse gland-tipped hairs, surface minutely rough textured. Leaves with 6–7(–8) pairs of secondary veins, sunken on the adaxial surface, raised on the abaxial surface, tertiary venation obscure on adaxial surface and obscure but visible on abaxial surface. Inflorescence an axillary cyme, 11–30-flowered, longer than leaves; hirsute up to and including the calyx with indumentum of translucent, white, spreading, multicellular, unbranched, eglandular hairs, and sparse, gland-tipped hairs and sessile glands. Peduncles 5–12 cm long. Bracts linear, $3\text{--}6.5 \times 0.3\text{--}1.8$ mm; hirsute on abaxial surface with appressed to spreading, translucent, multicellular, unbranched hairs, and sparse, gland-tipped hairs and sessile glands; adaxial surface with sparse, sessile glands and sparse, translucent, multicellular, unbranched hairs towards the apex and on margins. Pedicels 8–10 mm long, hirsute with erect, translucent, multicellular unbranched hairs, and sparse, gland-tipped hairs and sessile glands. Calyx free to near base, lobes $3\text{--}4 \times 0.9\text{--}1.1$ mm, linear-lanceolate, apex acute to obtuse, straight to reflexed, hirsute with erect, translucent, multicellular, unbranched hairs, and sparse, gland-tipped hairs and sessile glands on outer surface, and sessile glands on the inner surface. Corolla strongly bilabiate, purple, throat yellow, purple markings on 3-lobed lip extending from throat to base of the lobes; corolla inverted with 3-lobed lip in upper position and 2-lobed lip in lower position and with sparse, multicellular, unbranched hairs on outer surface of lips, otherwise glabrous apart from sessile glands in throat; tube *c.* 2 mm long;

2-lobed lip 11.8–13.5 mm long, lobes elliptic-ovate, 10–13 × 7–8 mm, wide-spreading or slightly overlapping in lower half; 3-lobed lip *c.* 11.8–13.5 mm, the three lobes 4–5 × 4–5 mm, lobes less than half the length of the lip, lobes usually equal or sometimes central lobe slightly smaller than lateral, slightly overlapping in lower half. Androecium in dorsal position; fertile stamens 2, arising 0.5–1 mm above the corolla base, filaments 6.5–7 mm long, bright yellow, swollen and bent in the middle, papillose or with minute glands in the swollen part of filament; anthers *c.* 2 mm long × 1 mm wide, dehiscing longitudinally; staminodes 3, reduced, 0.1–0.3 mm long, the central more reduced than lateral. Gynoecium 9–10 mm long; ovary 2.5–3 mm long, with sessile glands, glabrous or with very sparse, multicellular, unbranched, eglandular hairs; style glabrous, stigma capitate, slightly lobed, papillose. Capsule 9–24 mm long, 1–2.2 mm diameter, brown, sessile glands present, 2-valved, strongly twisted, dehiscing longitudinally along valves. Seeds elliptic, 0.45–0.5 × 0.2–0.25 mm. **Figs. 1–5.**

Additional selected specimens examined: Queensland. COOK DISTRICT: Glennie Tableland, ‘Bromley’, Oct 2004, *Fensham 5164 & Jensen* (BRI); Maloney’s Springs, left bank, Jun 1989, *Forster PIF5251* (BRI); Tozer Gap, Tozer Range, Jul 1948, *Brass 19408* (BRI, CANB); McIlwraith Range: Leo Creek Falls and Leo Creek 0.5 mile upstream from Falls, Jul 1978, *Butler 350* (CANB [CBG 7806268]); Australian National Botanic Gardens, Canberra (ex West Claudie River crossing on Iron Range road), Jan 1977, *Telford s.n.* (CANB [CBG 67783]).

Distribution and habitat: *Boea resupinata* is known from three broad areas; Glennie Tableland in Michingun Nature Refuge, Kutini-Payamu (Iron Range) National Park, and Leo Creek Falls in the Kulla (McIlwraith Range) National Park (**Map 1**). It grows in areas with reliable though periodically available moisture, as a lithophyte in shallow soil and leaf debris on cliff lines and rocks in shaded or semi-shaded rainforest gullies in sandstone escarpment areas, and on granite (Leo Creek), at elevations ranging from 60 to 140 m above sea level.



Fig. 1. *Boea resupinata*. Close up of flower showing bent filaments, corolla lips and lobes (grown from *Forster PIF5251*, BRI). Photo: G. Sankowsky.



Fig. 2. *Boea resupinata*. Close up of flower buds showing indumentum on inflorescence (grown from *Forster PIF5251*, BRI). Photo: G. Sankowsky.



Fig. 3. *Boea resupinata*. Hydrated plant fully turgid (in cultivation, grown from *Forster PIF5251*, BRI). Photo: G. Sankowsky.



Fig. 4. *Boea resupinata*. Partially desiccated plant (in cultivation, grown from Forster PIF5251, BRI). Photo: G. Sankowsky.



Fig. 5. Habitat and desiccated plants of *Boea resupinata* with dehiscent fruit in dry weather (Gray 9983, CNS). Photo: B. Gray.

Phenology: Flowering plants have not been collected in the wild, but plants cultivated at Atherton, north Queensland, have flowered in February and March; fruits have been collected in the wild in June, July and October.

Affinities: *Boea resupinata* is putatively most closely related to *B. magellanica* from Papua New Guinea but differs in its strongly bent staminal filaments (versus slightly bent), its leaf margins that are serrulate to serrate (versus entire to serrulate), and petal lobes with white multicellular hairs on the outside (versus glabrous). It differs from the

other two species occurring in Australia (*B. hygroscopica* and *B. kinnearii*) in its bent staminal filaments (versus curved to twisted). It also differs from the most similar Australian species *B. hygroscopica* in its petal lobes with white multicellular hairs on the outside (versus glabrous), the 3-lipped petal lobes < half the length of the lip (versus \geq half the length of the lip), obscure tertiary venation on leaf underside (versus usually raised and prominent), three staminodes (versus two), and crenate to serrulate leaf margins (versus crenate, serrate, denticulate to dentate and irregular) (Table 1).

Table 1. A comparison of morphology between *Boea resupinata* and allied species

Character	<i>Boea resupinata</i>	<i>Boea hygroscopica</i>	<i>Boea magellanica</i>
Corolla lobes	3-lobed lip in upper position, lobes < half the length of lip 2-lobed lip in lower position	3-lobed lip in lower position, lobes > or = to half the length of lip; the axis is variable within an inflorescence but rarely fully inverted 2-lobed lip in upper position	3-lobed lip in lower position, lobes < half the length of lip 2-lobed lip in upper position
Corolla overall shape	Strongly bilabiate, upper and lower lips not or slightly overlapping; lobes of 2-lobed lip elliptic-ovate and widely spreading; lobes of 3-lobed lip ovate and slightly overlapping.	Weakly bilabiate, with upper and lower lips often similar in size and overlapping; lobes of 2-lobed lip rounded and overlapping; lobes of 3-lobed lip rounded and overlapping.	Strongly bilabiate
Petal indumentum	White uniseriate multicellular hairs present on outer surface of lobes	Glabrous	Glabrous
Androecium	2 dorsal (due to flower inversion) fertile stamens 3 staminodes: 2 lateral and reduced; 1 ventral (due to flower inversion) and extremely reduced or sometimes absent	2 ventral fertile stamens 2 staminodes: both lateral and reduced	2 ventral fertile stamens 3 staminodes: 2 lateral and reduced; 1 dorsal and extremely reduced
Fertile stamen shape	Filaments strongly bent	Filaments not bent	Filaments slightly bent
Leaf margin	Serrulate to serrate	Crenate, serrate, denticulate to dentate and irregular	Entire to slightly serrulate
Tertiary venation on leaf underside	Obscure	Prominent, raised, sometimes obscured by hairs	Obscure to occasionally visible
Leaf hair colour	Silvery	White to rusty brown	Silvery
Capsule dimensions when dehiscent	13–23 mm \times 1.6–2 mm diameter, glabrous or with sessile glands	15–35 mm long \times c. 1 mm diameter, glabrous	7–20 mm long \times 1–2 mm diameter, glabrous or with sessile glands

Notes: *Boea resupinata* appears to be unique in the genus in that during anthesis the axis of the corolla is usually fully inverted, such that the 3-lobed lip is in the upper position, and the 2-lobed lip is in the lower position. In bud, the axis of the corolla is typical of species in the genus, with the 2-lobed lip in the upper position and the three-lobed lip in the lower position. As flowers open the pedicels twist such that the axis of the corolla is rotated and the lips move through a horizontal plane and ultimately are fully inverted. Flowers in an inflorescence of *B. hygroscopica* may also be twisted on the axis but are rarely fully inverted. In their generic description Puglisi & Middleton (2018) give the orientation of the corolla lobes as “upper lip 2-lobed, lower lip 3-lobed”, and in their key to species the relative lengths of the lobes of the “lower lip” (that is the 3-lobed lip) is one character used to distinguish several species (i.e. *Boea urvillei* C.B. Clarke, *B. kinnearii* and *B. hygroscopica* with lobes \geq half the length of the lip; *B. magellanica* and *B. dennisii* B.L. Burtt with lobes $<$ half the length of the lip). An amended key is provided in this paper.

In Gesneriaceae stomata are mostly restricted to the lower leaf surface (Sahasrabudhe & Stace 1974; Wiehler 1983). Under $\times 40$ stereo magnification the lower surfaces of living leaves of *Boea resupinata* are covered by minute mounds. Scanning electron micrographs of the leaf surface (Fig. 6) reveal that the stomata are raised on mounds and that the epidermal cells of the lower leaf surface are deeply sinuate. Histology of transverse leaf sections (Fig. 7) reveals that the mounds are formed by raised subsidiary and guard cells topped by a stoma, and that the stomatal mounds form a substomatal chamber that is connected to one or more stomata. Raised stomatal mounds have been observed in other Gesneriaceae (Sahasrabudhe & Stace 1974; Wiehler 1983; Kvist 1990; Jong *et al.* 2012; Pereira-Dias & Santos 2015) and *Boea resupinata* conforms to the observation by Wiehler (1983: 89) that there is a “strong correlation between gesneriad leaves with a thin, velvety lamina, abaxial epidermal cells with deep sinuations, and the presence of stomatal mounds”. Several

authors have examined and discussed the functional significance of the raised stomata (Wiehler 1983; Pereira-Dias & Santos 2015; Papanatsiou *et al.* 2017; Gray *et al.* 2020) and suggested that the raised mounds and increased size of the stomatal chamber facilitates gas exchange and accelerates transpiration, particularly in moist humid tropical environments, while the dense hairs covering the leaf surfaces maintain a humid microclimate that helps to prevent dehydration. They further suggest that the guard cells being raised above the epidermal surface may help to prevent flooding of the stomatal chamber in very wet conditions.

Boea resupinata demonstrates desiccation tolerance similar to that observed in *B. hygroscopica* (Bianchi *et al.* 1991; Proctor & Zoltán 2002), in that extreme air-dry plants may rehydrate, thereby enabling them to withstand prolonged dry periods. As such *B. resupinata* can be regarded as a ‘resurrection plant’. The dense, translucent, white indumentum on both leaf surfaces results in a striking silvery appearance to the leaves when plants are desiccated (Figs. 4 & 5) and is possibly an adaptation to reflect solar radiation, reduce heat absorption and reduce transpiration (Pereira-Dias & Santos 2015). These morphological traits are considered adaptations to survive heat and water stress due to the seasonality of rainfall and the limited water retention in the shallow soils of its rocky habitat.

Conservation status: *Boea resupinata* is known from few collections from several locations in three broad areas that remain poorly explored. The known locations are from remote areas within National Parks or Nature Refuges, and while no immediate threats were observed these populations are highly disjunct indicating little or no genetic connectivity. There is limited suitable habitat, and therefore a greater susceptibility to environmental changes associated with climate change, including changes to rainfall patterns and fire regimes. It is also conceivable that collecting by plant enthusiasts in the future might damage populations. A suggested conservation status for *Boea resupinata* is

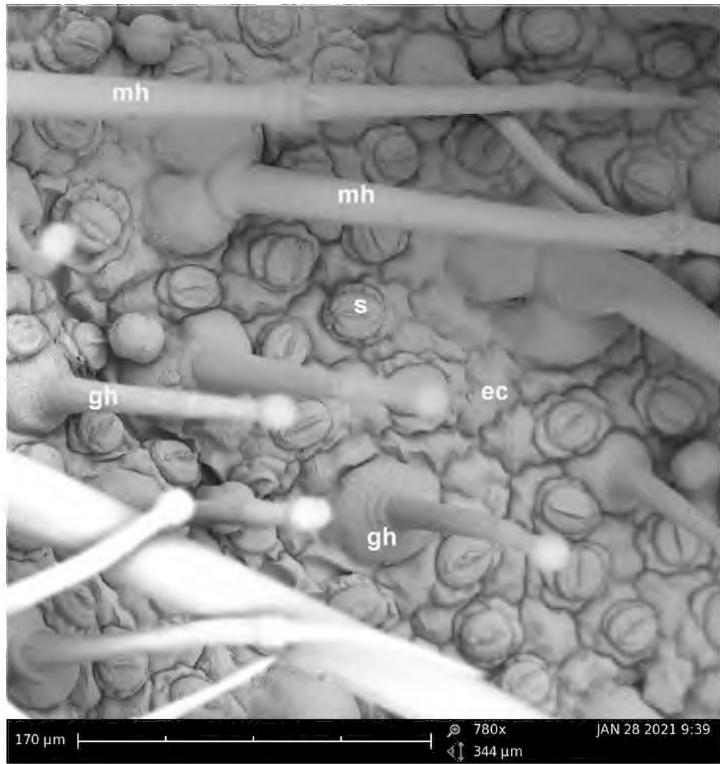


Fig. 6. SEM image of lower leaf surface of *Boea resupinata* showing raised stomatal mounds (s), sinuate epidermal cells (ec), multicellular hairs (mh) and glandular hairs (gh). Scale bar on image is 170 µm. All from *Gray 9983* (CNS). Photo: J. Whan.

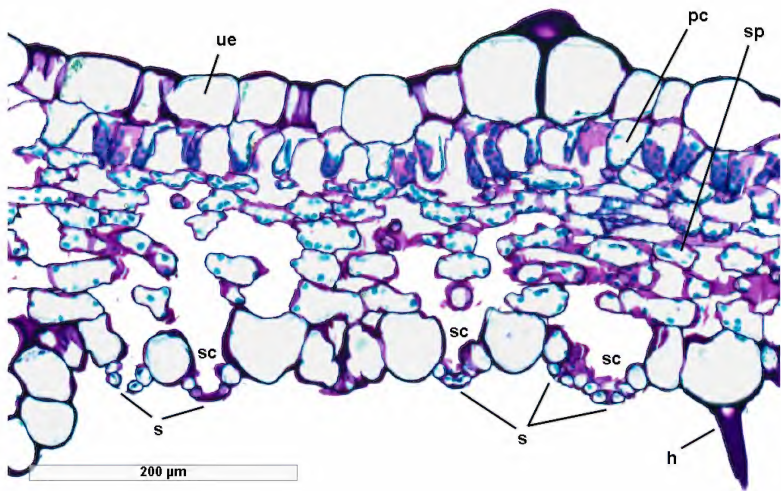


Fig. 7. Transverse section of *Boea resupinata* leaf showing upper epidermis (ue), palisade cells (pc), spongy cells (sp), stomata on raised stomatal mounds (s), stomatal chambers (sc) and hairs (h). Upper leaf surface uppermost in image. Scale bar on image is 200 µm. All from *Gray 9983* (CNS). Photo: J. Whan.

Vulnerable [VU B1ab(iii, iv)+B2ab(iii, iv)] using the IUCN Red List Categories and Criteria (IUCN 2012).

Etymology: From the Latin *resupinus*, bent backwards, referring to the “twisting” of flowers through about 180° as they open.

As flowers open the pedicels twist such that the axis of the corolla of *B. resupinata* is frequently fully inverted with the 3-lobed lip appearing in the upper position, and the 2-lobed lip in the lower position or rotated such that the lips are in a horizontal plane.

Partially modified key to the species of *Boea*, based on Puglisi & Middleton (2018) and following their couplet numbering

- 9a 3-lobed lip of corolla with lobes \geq half the length of the lip; leaf margin not entire [Australia and Waigeo]. 10
- 9b. 3-lobed lip of corolla with lobes $<$ half the length of lip; leaf margin entire or serrulate [Australia, Solomon Islands and Papua New Guinea] 12
- 10a Adaxial leaf surface with a strongly dimorphic indumentum of white and yellow multicellular hairs [Waigeo Island]. **B. urvillei**
- 10b. Adaxial leaf surface with uniform indumentum of colourless/white multicellular hairs [Australia]. 11
- 11a Abaxial leaf surface with multicellular eglandular hairs only; flowers white; fruit 0.8–1 cm long, straight or slightly twisted **B. kinnearii**
- 11b. Abaxial leaf surface with mixture of gland-tipped and eglandular hairs; flowers purple to blue; fruit 1.5–3.5 cm long, twisted **B. hygroscopica**
- 12a Ovary and fruit with multicellular hairs, sessile glands absent [Solomon Islands] **B. dennisii**
- 12b. Ovary and fruit glabrous or with sparse multicellular hairs and sessile glands 13
- 13a Petals glabrous; filaments slightly bent; ovary and fruit glabrous or with sessile glands; leaf margin entire to slightly serrulate [Papua New Guinea] **B. magellanica**
- 13b. Petals with multicellular hairs on outside; filaments strongly bent; ovary and fruit with sessile glands and sometimes with multicellular hairs; leaf margin serrulate to serrate [Australia] **B. resupinata**

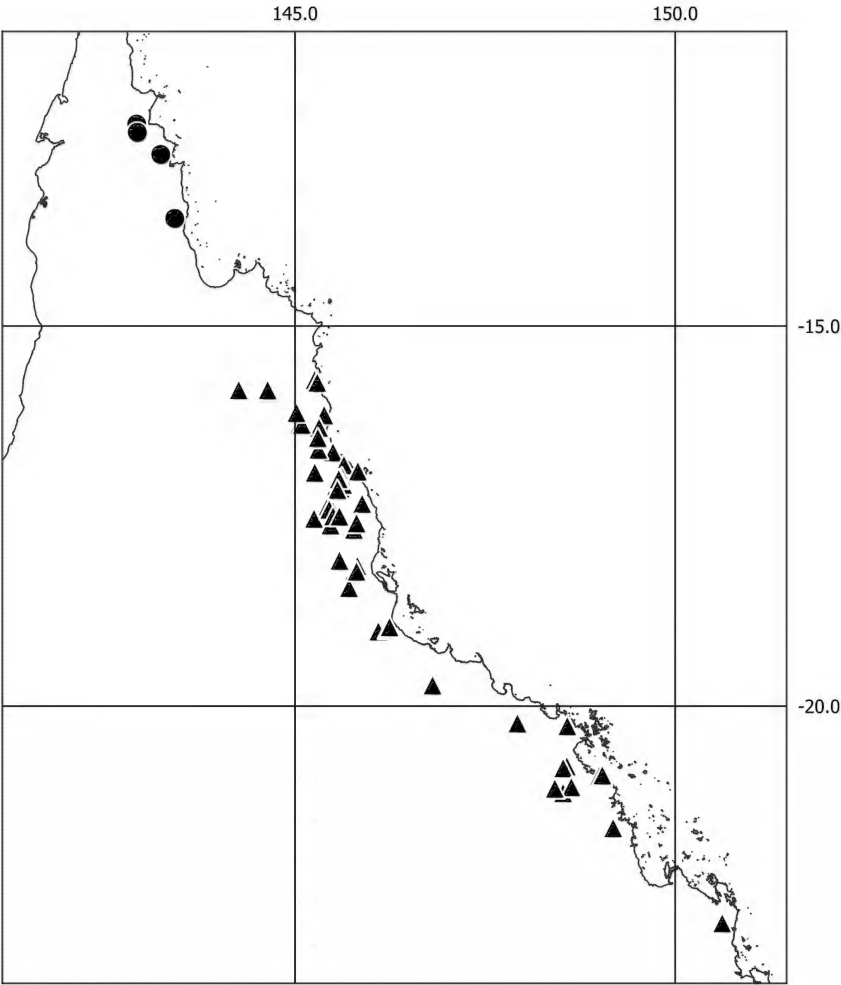
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Map 1. Distribution of *Boea resupinata* (●) and *B. hygroscopica* (▲).